ATTACHMENT J.4.81

DESIGN VERIFICATION

ED-12-4010

CONTROL NUMBER: 5-2-072
SITE PROCEDURE ED-12-4010
REVISION NO. 6

DESIGN VERIFICATION

ED-12-4010

Effective Date: September 30, 1997

Originator (Subject Expert): F. T. Jebens — Date: 9/30/97

Checker Concurrence: W. E. Kortier — Date: 9/30/97

APPROVED BY: A. C. Noble FAM, Engineering Design — Date: 10/1/97

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

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TABLE OF CONTENTS

LIST OF ATTACHMENTS

RECORD OF ISSUE/REVISIONS

DATE	REV. NO	DESCRIPTION AND AUTHORITY
09/14/94	0	Procedure written to define the design verification process initiated by S. Reutcke.
03/28/95	1	Revised procedure to clarify the design verification requirements, initiated by C. T. Beckett.
08/10/95	2	Revised procedure written to add definition of the engineering discipline review process, initiated by F. Jebens.
09/28/95	3	Revised procedure written to add requirements of critical safety systems to the engineering discipline review process, initiated by F. Jebens.
04/25/96	4	Revised procedure to clarify the design verification requirements and merge ED-12-4008, "Independent Design Review" into a single procedure, initiated by F. T. Jebens.
04/11/97	5	Revised procedure to clarify the design verification requirements per DOE design assessment report, initiated by D. G. Lunsford.
09/30/97	6	Revised procedure to align with the re-engineered Fluor Daniel Fernald, (FDF) organization. Initiated by G. C. Olbur.

1.0 PURPOSE

This procedure describes the methods for conducting and documenting Design verifications of project design documents prepared for use at the Fernald Environmental Management Project (FEMP).

2.0 SCOPE

This procedure applies to all FEMP projects (as defined in MS-1021) with designs developed in-house, as well as any subcontracted A/E or design organizations providing design activities or support. The extent to which individual disciplines or sections of this procedure will apply is dependent on the Performance Grade (PG) of the structures, systems or components (SSC) being designed. Small projects may be exempt upon the discretion of the Project Manager.

3.0 REFERENCES

1. ED-12-4002, "Conceptual Design Report"
2. ED-12-4003, "Design Criteria Package"
3. ED-12-4004, "Design Package"
4. ED-12-4005, "Calculation Preparation and Review Process"
5. ED-12-4011, "Vendor Submittals"
6. ED-12-4015, "Performance Grading"
7. ED-12-5001, "Engineering/Construction Document Control, (ECDC)"
8. ED-12-5002, "Engineering Design Change Processes"
9. ED-12-7001, "Engineering Interfaces"
10. CM-0001, "Configuration Management"
11. CT-2.1.5, "Constructibilty Reviews"
12. MS-1021, "Project Management"

4.0 RESPONSIBILITIES

Project Manager (PM)/Project Engineer (PE) - Assures that an appropriate design verification is performed by qualified engineer(s) including the services of Discipline Engineers, as deemed necessary. Verifications of design and design changes will receive design verification commensurate with that given to the original design. PM/PE assures that an appropriate design verification is performed by requesting discipline engineer(s) and/or other qualified expertise to review designs in accordance with this procedure and that the design is commensurate with standard engineering practice of that discipline.

4.0 **RESPONSIBILITIES** (cont.)

Engineering Design Functional Area Manager, (ED-FAM) - Has overall responsibility for the implementation of Design Verification at the FEMP. Establishes an Independent Design Review board as deemed necessary by this procedure or other FEMP requirements.

Discipline Engineer - Provides an independent assessment, as a senior level engineer/technologist, of the design in their discipline in accordance with this procedure, verifies/documents the appropriateness accordingly, and coordinates the design with project engineer(s) for completing the design package.

Project Engineer - Performs the design verification process in accordance with this procedure, documents the results accordingly, and transmits approved verification document to ECDC.

Engineering/Construction Document Control (ECDC) - Logs, files, and maintains design and design verification documents in accordance with approved procedures.

5.0 **GENERAL**

5.1 **Design verification measures** shall be applied to all (designated per MS-1021), design activities at the FEMP to verify the adequacy of the design. Determination of design review methods is accomplished by either of three methods, Design Reviews, Alternate Calculations, or Qualification Testing. The responsible design organization shall identify and document the particular design verification method(s) used. The results of design verifications shall be clearly documented with the identification of the verifier clearly indicated. Design verification shall be performed by any competent individual or group of individuals other than those who performed the original design but who may be from the same organization.

Note: ***Design verifications may be conducted at scheduled design milestones or at any intermediate point designated by the PM/PE. Typically, these activities are conducted at the completion of conceptual design and at various other stages of a project, as needed. For selected projects, design reviews should be conducted at the completion of conceptual design, at preliminary design completion (design basis), and at completion of detailed design.***

1. Design Reviews - These are critical reviews to provide assurance that the final document is correct and satisfactory. This may range from a detailed check of the complete design or document to a limited check of the approach and the results obtained. **(All required reviews must be documented)** Topical areas for consideration include functional requirements, input data, assumptions, design methodology, and verification requirements for interfacing organizations.

5.0 **GENERAL**

2. Alternate Calculations - These are calculations or analyses that are made with alternate methods to verify correctness of the original calculations or analyses. Typically a more simplified or less rigorous approach, but it must provide consistent results, and when performed, shall include a review of the appropriateness of assumptions, input data, and the computer program or other calculation method used.

3. Qualification Testing - Where design adequacy is to be verified by qualification tests, the test configuration shall be clearly defined and documented. These are performed in accordance with written test procedures incorporating specific acceptance criteria or performance indicators that validate the design.

5.2 **Design reviews** include three general approaches:

1. Internal Discipline Reviews - Review performed by FDF discipline specialist ranging from a detailed check of codes and calculations for the design or document to a limited check of the discipline specialty using experience and best management practice (all reviews must be documented).

2. External Discipline Reviews - Review performed by a subcontracted design organization ranging from a detailed check of codes and calculations for the design or document to a limited check of the discipline specialty using experience and best management practice.

3. Outside Expertise Reviews - Highly specialized personnel brought in to consult on technologies incorporating specific functional criteria or performance requirements that validate the design.

Note: ***Where required, Independent Design Reviews shall be performed by an experienced independent team, either as requested by the PM/PE, FDF senior management, or DOE field office. This review will be based on Performance Grade of PG-3 or higher or other mission related factors. This review can use any of the above approaches and could range from a detailed check of codes and calculations for the design or document to a limited check of the discipline specialty using experience and best management practice (all reviews must be documented).***

5.3 **Changes** to verified designs, as implemented through Site Procedure ED-12-5002, "Engineering Design Change Processes", will require design verification commensurate with that applied to the original design including an evaluation of the impact of the change on the overall design which may include Unreviewed Safety Question (USQ) Determination or technical review of Technical Safety Requirements (TSR).

6.0 PREREQUISITES

The design or design package shall have been prepared in accordance with approved procedures (i.e., ED-12-4004, "Design Package"), and all supporting design inputs and documentation shall be included.

6.1 Based on the size or complexity of the design effort, the Project Manager will assign either a Discipline Engineer or a Project Engineer to coordinate a group of discipline reviewers (presumably identified during alignment) to perform the design verification effort.

7.0 PROCEDURE

Design Verification shall be performed to verify the adequacy of the design. The procedure of reviewing, inspecting, testing, checking, or auditing is meant to determine whether data, items, processes, services, or documents conform to specified requirements.

7.1 DETERMINING THE DESIGN VERIFICATION METHOD

PROJECT MANAGER (PM)/PROJECT ENGINEER (PE)

1. Determine the preferred method of design verification to be used (Design Review, Alternate Calculation, or Qualification Testing) and notify the Project Engineer. Follow guidelines as detailed in Sections 7.3, 7.4, or 7.5.

7.2 DESIGN REVIEW PLANNING

This section applies to all three approaches to design review.

PROJECT MANAGER (PM)/PROJECT ENGINEER (PE)

1. Determine the preferred design review method to be used (Internal discipline, external, or outside expertise) and notify the Project Engineer.

PROJECT ENGINEER (PE)

2. With input from the project team, select an equally competent engineer or group of engineers to perform the required design verification ensuring that reviewers have the necessary capabilities/authority to represent their functional areas. (See ED-12-3001, "Design Initiation")

7.2 DESIGN REVIEW PLANNING (cont.)

PROJECT ENGINEER (PE)

3. The Project Execution Plan should designate when design verifications should be conducted at the completion of conceptual design, at preliminary design completion (design basis), and at completion of detailed design. Use Attachment A to direct reviewers for the appropriate level of review.

Note: If design verification is to be performed by a qualified discipline engineer, identify the type(s) of support. Prepare a Request for Engineering Services form per ED-12-7002. If an Independent Design Review is planned, go to Section 7.6.

7.3 PERFORMANCE

7.3.1 INTERNAL REVIEWS

ENGINEER (REVIEWER)

1. Review design package in accordance with functional requirements, codes and standards, and best management practice for the discipline specialty, documenting results and any comments for clarification or revision as necessary.

2. Set up and conduct internal reviews, as necessary, to check for design quality and consistency with other disciplines.

3. If the design reviewer accepts the design, initial and date the checklist item on the appropriate line.

4. If corrections, comments, or changes are required based on the design review, submit to the Originator and schedule a meeting, if necessary, to resolve the concerns.

5. Upon resolution of all corrections, comments or changes, sign and date the Document Review Comment Sheet (Attachment C), and return it to the PE.

7.3 PERFORMANCE (cont.)

7.3.1 INTERNAL REVIEWS (cont.)

PROJECT ENGINEER (PE)

6. Upon receipt of the verified design package, review the Design Verification Checklist (Attachment B) to assure all required design verifications were performed, all comments, corrections or changes have been resolved. Also review the Document Review Comment Sheet to assure the Originators and Reviewers names are present and legible.

7. Forward the verified design package to ECDC for logging, processing, and filing.

8. Complete the specific discipline portion of the Design Activity Closeout, procedure ED-12-8001, when the Definitive Design has been approved.

7.3.2 EXTERNAL REVIEWS

PROJECT MANAGER (PM)/PROJECT ENGINEER (PE)

1. If design development and/or verification is to be supplemented by a qualified design subcontractor, identify the type(s) of support to be performed.

PROJECT ENGINEER (PE)

2. Develop a work instruction in accordance with ED procedures which includes requirements for the support effort. Prepare a Purchase Requisition per ED-12-2006 and AC-0001, "Request for Purchase."

3. Direct or oversee performance of the work, and evaluate the results against the expectations. Verify, sign, and date the time sheets or invoices, as submitted.

DESIGN ORGANIZATION

4. Review design package in accordance with functional requirements, codes and standards, and best management practice for the discipline specialty, documenting results and any comments for clarification or revision as necessary.

5. Prepare calculations or analyses to verify appropriateness of assumptions, input data, and calculation method to the functional requirements.

7.3.2 EXTERNAL REVIEWS (cont.)

DESIGN ORGANIZATION

6. If the concepts, calculations, and analyses confirm compliance to requirements, proceed with verification of integration of design concepts in the design, as appropriate, for the stage of the project cycle.

7. Coordinate internal discussions, as necessary, to check for design quality and consistency with other disciplines.

8. Sign and date the Document Review Comment Sheet, and return it to the PE.

PROJECT ENGINEER

9. Upon receipt of the verified design package, review the Design Verification Checklist to assure all required design verifications were performed, all comments, corrections or changes have been resolved. Also review the Document Review Comment Sheet to assure the Originators and Reviewers names are present and legible.

10. Forward the verified design package to ECDC for logging, processing, and filing.

7.3.3 OUTSIDE EXPERTISE REVIEWS

PROJECT MANAGER (PM)/PROJECT ENGINEER (PE)

1. If design development and/or verification is to be supplemented by a qualified subcontractor or teaming partner, identify the type(s) of support to be performed. Prepare either a Teaming Partner Request for Service form per HR-128, "Temporary Assignment", or a purchase requisition for subcontract support per AC-0001, "Request for Purchase."

PROJECT ENGINEER (PE)

2. Develop a work instruction in accordance with ED procedures which includes requirements for the support effort. The work instruction shall also identify prerequisites including calibrated instrumentation, equipment, personnel training requirements, environmental conditions for performance and provisions for site access.

3. Direct or oversee performance of the work, and evaluate the results against the expectations. Verify, sign, and date the time sheets or invoices, as submitted.

7.4 ALTERNATE CALCULATIONS

PROJECT ENGINEER (PE)

1. Determine if a more simplified or less rigorous approach should be performed. The review should include appropriateness of assumptions, input data, and code or method used.

   Note: The extent to which individual sections of this procedure will apply is dependent on the Performance Grade (PG) of the structures, systems or components (SSC) being designed.

DESIGN ORGANIZATION

2. Prepare an alternate calculation or analyses to verify the Originators calculation or analysis in accordance with ED-12-4005, "Calculation Preparation and Review Process".

   Note: If an alternate calculation is prepared, verify appropriateness of assumptions, input data, and calculation method or computer code used. The alternate method used for comparison may be a more simplified or less rigorous approach which may not exactly check the original calculation or analysis, but it must provide results consistent with the original calculation or analyses.

3. Attach the alternate calculation or analysis to the Design Verification Checklist.

PROJECT ENGINEER (PE)

4. If the alternate calculation or analysis confirms the original design, initial and date the checklist item on the appropriate line with a note referencing the attached alternate calculation or analysis.

5. If the alternate calculation or analysis does not confirm the original calculation or analysis, contact the Originator and schedule a meeting to resolve the concerns.

   Note: If a concern cannot be resolved between the design Originator and Reviewer(s), the PM/PE shall be consulted. If the PM/PE cannot resolve the concern, the concern will be elevated to the ED Functional Area manager for final resolution.

7.4 ALTERNATE CALCULATIONS (cont.)

PROJECT ENGINEER (PE)

6. Review the Design Verification Checklist to assure all required design verifications were performed, all comments, corrections or changes have been resolved, and the reviewers initial and date of review are legible. Also review the Document Review Comment Sheet to assure the Originators and Reviewers names are present and legible.

7. Forward the verified design package to ECDC for logging, processing, and filing.

7.5 QUALIFICATION TESTING

PROJECT ENGINEER

1. If design verification is to be achieved by qualification testing, identify the type(s) of qualification test(s) to be performed.

2. Develop a qualification test work instruction (Use a specification, if appropriate) in accordance with ED procedures which shall include test requirements and acceptance criteria. The test work instruction shall also identify all test prerequisites including calibrated instrumentation, equipment, personnel training requirements, environmental conditions for test performance and provisions for data acquisition and retention.

3. Direct or oversee performance of the qualification test, and evaluate the test results against test acceptance criteria. If test results indicate acceptable performance, sign and date the Document Review Comment Sheet, and attach the qualification test results.

4. If the qualification test results indicate that modifications to a SSC are required, document the basis and nature of the design change and initiate a DCN in accordance with procedure ED-12-5002.

DESIGN ORGANIZATION

5. Develop the design change and the verification method and repeat above procedure steps as necessary.

7.6 INDEPENDENT DESIGN REVIEW

7.6.1 INDEPENDENT DESIGN REVIEW PLANNING

PROJECT MANAGER (PM)/PROJECT ENGINEER (PE)

1. If design verification is required to be supplemented by an independent design review, identify the type(s) of support to be supplied.

PROJECT ENGINEER (PE)

2. With input from the project team, select an equally competent engineer or group of engineers to support the design review team.

3. Arrange for design information to be supplied to the team based on project schedules allowing sufficient time for the preparation and conduct of the design reviews.

Note: Independent reviews will be scheduled in advance for projects with PG-3 or higher graded SSCs, and can be performed on other projects as requested (by the PM/PE, DOE and/or EPA) for others.

Note: The DOE field office may wish to conduct Management Reviews on any given project. This should be determined and specified during the project planning phase.

ED-FAM

4. Identifies a core of senior engineers from key disciplines to serve on the Independent Design Review Team.

5. Ensures that the Independent Design Review Team comments are documented and distributed to the responsible PM/PE.

PROJECT ENGINEER (PE)

6. Verify the design package is prepared in accordance with ED procedures, and attach the Design Verification Checklist. (Attachment B)

7. Distribute the design package to the assigned reviewer(s) with a Document Review Comment Sheet (Attachment C) signed and dated by the Originator.

8. Process independent design review comments per Section 7.3.1.

8.0 RECORDS

The following records will be generated as a result of this procedure:

8.1 Copies of the Design Verification package.

8.2 All other correspondence directing action will be processed per Site Procedure ED-12-5001, "Engineering/Construction Document Control,(ECDC)."

9.0 DRIVERS

1. RM-0012, "Quality Assurance Program"
2. RM-0016, "Management Plan"

10.0 DEFINITIONS

Conceptual Design - The formative engineering stage in the design of a system, process, or facility based on user requirements established and accepted by management that establishes the location, size, capacity, and functional need of the project.

Constructibility - The optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve overall project objectives.

Definitive (Title II) Design - This design phase finalizes the development of the design based on approved Title I design. Title II design includes any revisions required of the Title I effort; preparation of final drawings, specifications, bidding documents, cost estimates, and coordination with all parties which might affect the project; development of firm construction and procurement schedules; and assistance in analyzing proposals or bids.

Design Change Notice (DCN) - A document used to identify, formalize a request for, or provide changes to an approved design drawing, specification, or other governing document. It has the same authority as a revision to the affected document when approved by the design organization.

Design Criteria - Technical data and scope information developed during project planning, feasibility studies, and conceptual design for use in developing the definitive design.

Design Review - Systematic evaluations of designs held at predetermined times to ensure that the design satisfies the design criteria. During design review, potential problems are identified, responsibility for resolution assigned, and any necessary changes completed. This review includes operability, maintainability, and constructibility functions.

10.0 **DEFINITIONS** (cont.)

Design Review Team - Personnel who, as a group, are knowledgeable in elements of the design under review and the design requirements. The PE chairs the project design review team which comprises representatives from appropriate disciplines and Functional Areas, and may include on-site and/or off-site personnel.

Discipline Engineer - That person trained, experienced, and functioning as the Subject Expert (SE) on a specific area of engineering expertise (e.g., Civil, Chemical, Electrical, Mechanical, or Structural). The lead discipline engineer is authorized to sign FDF drawings and specifications for that discipline.

Equally Competent - A person having relatively similar experience or training in a discipline.

Expert - A person with a special skill or knowledge representing mastery of a particular subject.

Independent Design Review - A documented review of design products or processes that has the express purpose of serving to validate, cross-check, or analyze the design developed by proponents for a project. An independent design review also serves as a vehicle for verifiying the basis for design and/or design process. It is usually performed by persons independent from the performing organization.

Maintainability - Addresses frequency, cost and ease of maintenance incorporated in the design phases of a project.

Operability - Focuses on minimizing the post-startup life cycle costs of a facility. This addresses all of the facility operation, logistics, and support issues appropriate during a project's design phases.

Performance Grade (PG) - The classification of an activity or function of a system, structure or component associated with a nuclear or non-nuclear facility in terms of:

1. **Safety Considerations** involving the consequences of its failure to prevent or mitigate the release of radioactive materials or energy, or hazardous materials.

2. **Mission Importance Considerations** involving the consequences of its failure impacting schedule delay, stakeholder reaction, or project cost.

3. **Life-Cycle Considerations** involving the design life or intended use/consequence of the SSC or Activity.

4. **Complexity Considerations** involving the degree of regulatory, design, construction, process, and/or management coordination required.

10.0 **DEFINITIONS** (cont.)

Preliminary Design (TITLE I) - Continues the engineering effort utilizing the conceptual design and the project design criteria as a basis for project design development. Preliminary design develops the requirements and criteria which will govern the definitive design. Tasks include preparation of preliminary planning and engineering studies, preliminary drawings and outline specifications, life-cycle cost analysis, preliminary cost estimates, and scheduling for project completion. Preliminary design provides identification of long lead procurement items and analysis of risks associated with continued project development.

Qualified Individual - A person having the knowledge, experience, or training to technically review a discipline area.

Technical Reviews - Specific technical evaluations of function, operability, constructibility or maintainability that are incorporated into a stage of design review.

Verification - The act of reviewing, inspecting, testing, checking, auditing, or otherwise determining whether data, items, processes, services, or documents conform to specified requirements.

ATTACHMENT A-REVIEWER GUIDELINES (Continued)

30 Percent Inappropriate Comments

1. Details of project that are to be developed during Definitive Design (Title II)
2. Recalculation of design calculations
3. Comments which are intuitive and not supported by facts, technical information, standards, etc.

Appropriate Comments for 90 Percent Design

1. Comments on drawing detail supported, by facts, codes, standards, etc.
2. Omissions, errors, or conflicts in design supported by facts, codes, standards, etc.
3. Minor changes to layout
4. Spot checking of final design calculations (review of Design Verification methods and documents)
5. Relationship to other projects
6. Comments on construction specifications, including adequacy of submittal requirements, sequence of operations
7. Comments on cost estimate and schedules

90 Percent Design Inappropriate Comments

1. Personal preference or opinion on how project should be designed
2. Comments on design concepts which were an appropriate comment at 30 percent.
3. Comments that change functional requirements, design criteria, or other preliminary engineering (Title I)
4. Comments stated for understanding the project or that cause unnecessary work

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a generic sample only. Checklist must be customized for the specific design under review.

	YES	NO
I. GENERAL		
A. HAVE FUNCTIONAL AND OPERATIONAL REQUIREMENTS AND DESIGN CRITERIA BEEN SPECIFIED FOR THIS DESIGN?	☐	☐
1. Were they used in design process?	☐	☐
2. Were all areas adequately covered in design?	☐	☐
3. Are design assumptions reasonable and adequately identified and described?	☐	☐
4. Are the applicable codes, standards, and regulatory drivers, including issue and addenda, properly identified?	☐	☐
5. Have they been met?	☐	☐
6. Was the design method appropriate?	☐	☐
7. Is the output reasonable compared to inputs?	☐	☐
B. HAVE HUMAN FACTORS BEEN CONSIDERED IN THE DESIGN?	☐	☐
1. Are controls well organized?	☐	☐
2. Are controls located for efficient operation?	☐	☐
3. Can monitoring devices be easily and accurately read?	☐	☐
4. Can all operations be performed safely without danger to user or facility?	☐	☐
5. Have Human Services requirements been considered? (Change rooms, offices, communications, etc.)	☐	☐
6. Can maintenance be performed easily?	☐	☐
7. Have operations requiring special skills or special attention been minimized?	☐	☐
8. Does the design adequately consider remote operability or maintainability requirements?	☐	☐
9. Does the design minimize potential for human error? *(Unique fittings to preclude inadvertent error in making routine connections, clear labeling and logical layouts to preclude mistakes in valve operations, minimum reliance on irregular manual operations, etc.)*	☐	☐
C. COST ESTIMATING		
1. Have cost-benefit studies been made? Are they realistic?	☐	☐
2. Are cost estimates realistic?	☐	☐
3. Have costs, consistent with requirements, been minimized?	☐	☐
D. CONSTRUCTION		
1. Are critical parameters to be controlled during construction clearly identified?	☐	☐
2. Has constructibility been considered?	☐	☐
3. Is equipment (commercial and other) available?	☐	☐
4. Are specified materials appropriate based on availability, cost and application?	☐	☐
5. Has previous construction experience been considered?	☐	☐

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a generic sample only. Checklist must be customized for the specific design under review.

	YES	NO
E. FAILURE MODES		
1. Have redundance, diversity, and separation requirements for structures, systems, and items been considered?	☐	☐
2. Have failure modes of critical elements been analyzed?	☐	☐
3. Have failure effects, requirements related to structures, systems, and items (including definition of events and accidents which they must withstand) been considered?	☐	☐
F. HAS THE PLANT ENVIRONMENT'S EFFECT ON THE DESIGN BEEN CONSIDERED?	☐	☐
G. HAS THE DESIGN'S EFFECT ON PLANT AND OFFSITE ENVIRONMENT BEEN CONSIDERED?	☐	☐
H. HAVE TRANSPORTABILITY REQUIREMENTS BEEN CONSIDERED?	☐	☐
I. HAVE NATURAL PHENOMENA DESIGN CRITERIA BEEN PROPERLY ESTABLISHED?	☐	☐
J. DOCUMENT CONTROL	**YES**	**NO**
1. Are drawings, equipment, valve and instrument numbering systems consistent with plant standards?	☐	☐
2. Has completeness of drawings and specifications been verified?	☐	☐
3. Are acceptance criteria specified in design documents sufficient to allow verification that design requirements have been adequately accomplished?	☐	☐
4. Are design details complete and accurate? Are tolerances properly called out?	☐	☐
5. Have obvious errors and omissions been corrected?	☐	☐
6. Are adequate SSC identification requirements specified?	☐	☐
K. RECORDS CONTROL		
1. Are requirements for record preparation, review, approval, retention, and storage adequately specified?	☐	☐

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

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	YES	NO
L. INTERFACE CONTROL		
1. Have the basic functions of each structure, system, and item been defined?	☐	☐
2. Have interface requirements including definition of functional and physical interfaces involving structures and items been considered?	☐	☐
3. Have layout and arrangement requirements (including ventilation criteria) been met?	☐	☐
4. Have interdisciplinary checks been completed?	☐	☐
5. Has the simplicity of the design been optimized?	☐	☐
6. Have energy conservation design features been incorporated to minimize the consumption of energy?	☐	☐
7. Have underground utilities been appropriately considered?	☐	☐
8. Have plant as-builts been fully considered in interface review?	☐	☐
II. NUCLEAR AND INDUSTRIAL SAFETY		
A. GENERAL		
1. Have requirements been provided to prevent undue risk to the health and safety of plant personnel and the public and to assure protection of the environment?	☐	☐
2. Has the need for safety studies/reports been identified and planned for?	☐	☐
B. SAFEGUARDS AND SECURITY		
1. Have access and administrative control requirements for plant safeguards and security been provided?	☐	☐
C. ENVIRONMENTAL SAFETY AND HEALTH		
1. Have permissible personnel radiation exposures or specified areas and conditions been considered?	☐	☐
2. Has the design properly considered the control of radiation contamination and exposure to plant personnel and the public?	☐	☐
3. Has the As Low As Reasonably Achievable **(ALARA)** review been completed?	☐	☐
4. Have safety requirements dealing with source containment for preventing personnel injury been considered?	☐	☐
5. Have notches, cracks, crevices and rough surfaces that might retain radioactivity been minimized in the design?	☐	☐
6. Does the design provide for control of gaseous, liquid and solid waste output?		

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a generic sample only. Checklist must be customized for the specific design under review.

	YES	NO
D. INDUSTRIAL SAFETY		
1. Have fire protection and fire resistance requirements been provided?	☐	☐
2. Have the following safety requirements been provided?	☐	☐
a. Restricting use of dangerous materials?	☐	☐
b. Escape provision from enclosures?	☐	☐
c. Grounding of electrical systems?	☐	☐
d. Barriers and railings?	☐	☐
e. Emergency and first aid equipment?	☐	☐
f. Evacuation provisions?	☐	☐
E. CRITICALITY SAFETY	**YES**	**NO**
1. Has a criticality safety evaluation been done?	☐	☐
2. If changes in operation or equipment are made, would this change the conclusions of the evaluation (USQ D)?	☐	☐
3. Are the proposed controls adequate to assure criticality safety (e.g., administrative, configuration, process)?	☐	☐
III. TECHNICAL/PLANT ENGINEERING		
A. GENERAL		
1. Are materials process, parts, and equipment suitable for required application?	☐	☐
2. Have performance requirements been considered?	☐	☐
a. Capacity?	☐	☐
b. Rating?	☐	☐
c. System output?	☐	☐
d. Reliability?	☐	☐
3. Have calculations been performed and provided to support design output?	☐	☐
4. Are control devices of proper type and adequate for purpose?	☐	☐
5. Have previous operating and maintenance experience been considered?	☐	☐
6. Has the use of mechanical equipment in radioactive areas been minimized?	☐	☐
7. Has technical risk assessment been considered (i.e., state-of-the-art versus proved design)?	☐	☐
8. Have all necessary codes and standards been identified and a compliance evaluation considered?	☐	☐
9. Has testing been properly addressed?	☐	☐
10. Has application of automatic data processing been appropriately considered?		

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a **generic** sample only. Checklist must be customized for the specific design under review.

	YES	NO
B. PROCESS DEVELOPMENT		
1. Have design conditions been considered?	☐	☐
a. Process Flow Diagram?	☐	☐
b. Pressure/Temperature?	☐	☐
c. Fluid chemistry (Corrosivity, viscosity, solids content)?	☐	☐
2. Have chemistry requirements such as provisions for sampling limitations of fluid chemistry been provided for?	☐	☐
3. Is pilot plant or development required and planned?	☐	☐
4. Are key process control points identified?	☐	☐
C. MECHANICAL		
1. Have mechanical requirements been considered?	☐	☐
a. Vibration?	☐	☐
b. Stress?	☐	☐
c. Shock?	☐	☐
d. Reaction forces?	☐	☐
2. Have structural requirements for equipment foundations and pipe supports been provided?	☐	☐
3. Have hydraulic requirements been considered?	☐	☐
a. Pump net positive suction heads?	☐	☐
b. Allowable pressure drops?	☐	☐
c. Allowable fluid velocities?	☐	☐
d. Anti-siphoning provisions?	☐	☐
e. Elimination of inadvertent transfer routes?	☐	☐
f. Overflow provisions?		
g. The design pressures are such that they perform the required function and are minimally in excess of the resistance at the static head?	☐	☐
h. Dynamic pressure addressed, where applicable?	☐	☐
4. Have breakpoints been properly identified for system isolation or for line and valve classes?	☐	☐
D. ELECTRICAL		
1. Have electrical requirements been met?	☐	☐
a. Source of power?	☐	☐
b. Voltage?	☐	☐
c. Raceway requirements?	☐	☐
d. Electrical insulation requirements?	☐	☐
e. Motor requirements?	☐	☐
f. Proper function and routing?	☐	☐
g. Have cable and conduit schedules been prepared by the designer?	☐	☐

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a generic sample only. Checklist must be customized for the specific design under review.

	YES	NO
E. CIVIL		
1. Have design loads been provided for the following?	☐	☐
a. Seismic?	☐	☐
b. Wind?	☐	☐
c. Thermal?	☐	☐
d. Dynamic?	☐	☐
2. Have anticipated environmental conditions during storage, constructions, and operation been considered?	☐	☐
3. Have utility systems interface requirements been considered and established?	☐	☐
4. Have requirements for concrete been properly identified?	☐	☐
F. MATERIALS		
1. Concrete finishes for protective coatings?	☐	☐
2. Proper additives, release agents, or curing compounds?	☐	☐
a. Compatibility with existing plant equipment and processes?	☐	☐
b. Electrical insulation properties?	☐	☐
c. Protective coatings?	☐	☐
d. Corrosion resistance?	☐	☐
e. Radiation resistance?	☐	☐
f. Physical and chemical properties?	☐	☐
g. Welding materials?	☐	☐
h. Special processes?	☐	☐
I. Cathodic protection?	☐	☐
3. Are the specified materials compatible with each other and the environmental conditions to which they will be exposed?	☐	☐
G. CRITICAL SAFETY SYSTEMS		
1. Have critical safety systems been identified?	☐	☐
2. Does the application require redundant safety components?	☐	☐
3. Have the supporting calculations been verified?	☐	☐
4. Are special system operability tests required?	☐	☐
IV. QUALITY ASSURANCE		
A. ARE APPROPRIATE QUALITY ASSURANCE REQUIREMENTS SPECIFIED?	☐	☐
B. HAS ADEQUATE ACCESSIBILITY BEEN PROVIDED TO PERFORM THE IN-SERVICE INSPECTION REQUIRED DURING PLANT LIFE?	☐	☐
C. HAVE QA INSPECTION REQUIREMENTS BEEN PROPERLY IDENTIFIED?	☐	☐
D. ARE ACCEPTANCE CRITERIA INCORPORATED INTO THE DESIGN DOCUMENTS TO ALLOW VERIFICATION OF DESIGN REQUIREMENTS?	☐	☐

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a **generic** sample only. Checklist must be customized for the specific design under review.

	YES	NO
D. MAINTENANCE AND REPAIR		
1. Have prior maintenance and repair experience related to similar systems and items been considered?	☐	☐
2. Have adequate maintenance features and requirements been specified?	☐	☐
3. Are items requiring frequent maintenance easily accessible?	☐	☐
4. Has repairman safety been considered?	☐	☐
5. Are spare parts appropriately considered?	☐	☐
6. Are accessibility and other design provisions adequate for performance for required maintenance replacement and repair been considered?	☐	☐
7. Have opportunities and limitation of remote maintenance and operation been considered?	☐	☐
8. Have instrument calibration and preventive maintenance been considered?	☐	☐
9. Have decontamination and decommissioning been considered?	☐	☐

ATTACHMENT B-DESIGN VERIFICATION CHECKLIST

NOTE: This is a generic sample only. Checklist must be customized for the specific design under review.

	YES	NO
V. PRODUCTION		
A. GENERAL		
1. Are accessibility, maintenance, repair, and in-service inspection and the conditions under which they will be performed considered (Overlay drawings should be provided if requested by the Project Manager)?	☐	☐
2. Are operation and maintenance features consistent with FDF policies and procedures?	☐	☐
3. Are adequate handling, storage, cleaning, and shipping requirements specified?	☐	☐
4. Have OSHA and DOE requirements for operation and maintenance activities been specified?	☐	☐
5. Have needs for bypasses or operating spares been established?	☐	☐
6. Have personnel requirements and limitations, including the qualifications and numbers of personnel available for plant operations and maintenance been considered?	☐	☐
7. Have assets been properly identified for use by the Facility Owner and Property Management personnel?		
B. STARTUP AND TESTING		
1. Have adequate pre-operational test requirements been adequately specified, including acceptance criteria?	☐	☐
a. Is testing specified for critical safety systems and components?	☐	☐
2. If Qualification Testing will be used to verify design adequacy:	☐	☐
a. Is the testing identified and documented?	☐	☐
b. Have written test procedures been developed?	☐	☐
c. Are acceptance criteria specified?		
C. OPERATION		
1. Have operation requirements under various conditions been considered?	☐	☐
a. Plant start-up?	☐	☐
b. Normal process operation?	☐	☐
c. Process shutdown?	☐	☐
d. Plant emergency operation?	☐	☐
e. Special or infrequent operation?	☐	☐
f. System abnormal or emergency operation?	☐	☐
2. Are critical parameters to be controlled during operation clearly identified?	☐	☐

ATTACHMENT D

DOCUMENT REVIEWER GUIDELINES

1. Review for your specific area of responsibility and/or expertise. Do not review areas of the document where you do not have responsibility and or/expertise.

2. Direct comments to the actions within the scope of the design review. Modifications of component design, new requirement, or further design development should be addressed in the review.

3. Record comment on the Review Comment Sheet. If you want to mark the document with your comments, make notation on the Review Comment Sheet such as, "See comments marked on copy of the document," or "See comments on page 4, 7, and 19." Return both the Review Comments Sheet and any marked copy.

4. Avoid writing questions. If necessary to resolve a conflict, call the SE named on the cover sheet and ask for clarification. If you care to make a suggestion to the SE, indicate that your comment is only a suggestion by marking the comment with the word SUGGESTION.

5. Indicate that a comment is a **Significant Review Comment** (SRC) with a (√) if the change indicated:

   - is required to meet FDF policies, procedures, or established regulations applicable to the FEMP operation,
   - has significant procedural impact for a safe and efficient operation,
   - is technically incorrect,
   - is to request clarification of a statement that is not clear.

   The following comments should <u>not</u> be marked as significant review comments:

   - Suggestions
   - Organizational title change
   - Questions to the SE
   - Grammar/spelling correction
   - Personal opinions/preferences

6. If material is technically correct, do not change it because of personal opinion. You may, however, indicate a more concise or clear way to communicate the step as a SUGGESTION.

7. Indicate by signature that comment resolutions have been incorporated.

ATTACHMENT C-DOCUMENT REVIEW COMMENT SHEET

SUBJECT EXPERT:	REVIEWING DIVISION:	DATE:
DOCUMENT NUMBER AND TITLE:		COMMENTS DUE BY:

ITEM NO.	REVIEWER NAME	PAGE NO. /SECTION	COMMENT	SRC	COMMENT RESOLUTION
				✓	

SIGNIFICANT REVIEW COMMENT RESOLUTION APPROVAL SIGNATURE:		DATE:
DESIGN COMMENTS INCORPORATED - PE SIGNATURE:	DESIGN VERIFICATION ACCEPTED - PM SIGNATURE:	DATE: